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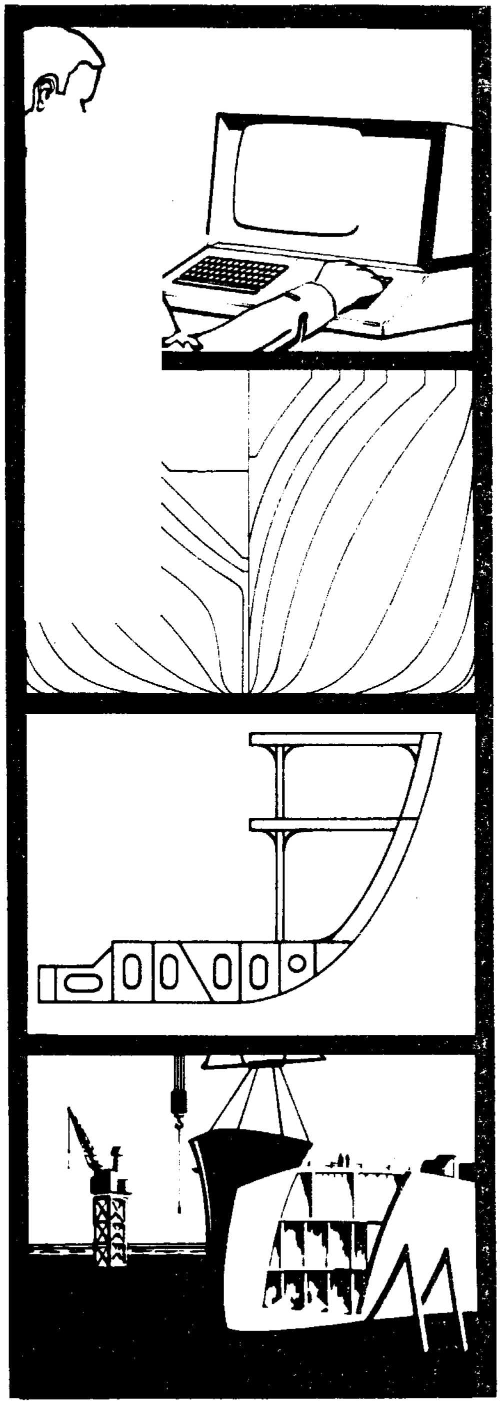

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SPCS -- A COMPREHENSIVE SYSTEM FOR SHIPYARD PRODUCTION CONTROL

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INTRODUCTION

With shipbuilding capacity worldwide well in excess of demand and competition for orders extremely fierce, shipyards must ensure that all resources are used effectively. Each man on the shop floor, each foreman and manager must be able to carry out the work required of him - which means that he must be provided with all the required information on the work to be done and the means to carry it out. He must not receive too much information and the information presented must be in a form which can be readily assimilated.

The competition for orders, quite apart from resulting in shorter lead times, has resulted in shipyards building a wider range of products than was envisaged even a short time ago. For example, a European shipyard which for many years built only VLCCS now markets a range of products from offshore supply vessels through floating factories to large LNGCS. The potential. variety of individual operations within a shipyard in this situation is much higher than in the case of a single product facility. The information channels used in this production system are similarly going to require greater capacity, speed and accuracy.

SYSTEMS DEVELOPMENT IN RETROSPECT

The equipment and hardware in shipyards has, over the years, become more and more specialized. As the variety of products reduced, so physical layouts became more rigid. As shipyards became more organized. so planning departments grew in size and so too did the size of computer planning tools. There was a tendency to centralize decision making, sometimes removing the input which could have been made by first line supervisors. It quickly became apparent that the computer tools were not sufficiently representative of what was actually happening on the shop floor.

In an attempt to become more realistic, they became more and more detailed. For example, the number of activities in a network grew to five and ten thousand and beyond. The updating problems were immense and the technique lost its attraction because it was misused. To redress this situation, full authority was sometimes handed back to foremen and head foremen. Unfortunately, both the product and the shipyard were by now more complex, and there was no way of supplying the required amount of information to enable control to be maintained.

In the situation of over-centralization, the tools used attempted to predict the state of the production system over time without, at the same time, supplying the means to control production. Prediction and reality tended to diverge.

In the situation of over decentralization, the means of control were there, but there was an absence of a clearly stated set of detailed objectives. It is probably true to say that the rejection of both these solutions leaves an organizational vacuum.

ORGANIZATION DEVELOPMENT

An immediate, partial solution is to attempt to align the staff function much more closely to the production organization, giving a typical structure as shown in Figure 1. This reflects the position shown in Figure 2. As successively lower levels of the management hierarchy are studied, the amount of information to be processed grows and the cycle time for control decreases. It is these two, incompatible, factors which render the approach towards increasing centralization of the control of all operations ineffective.

The structure in Figure 1 also has a more subtle purpose. This is to remove the feeling of remoteness, sometimes bordering on antipathy, between 'planning' and 'production' by combining them at each major level and within each major department in the organization. Thus, at the shop floor, foremen and operations control staff work together as a team,

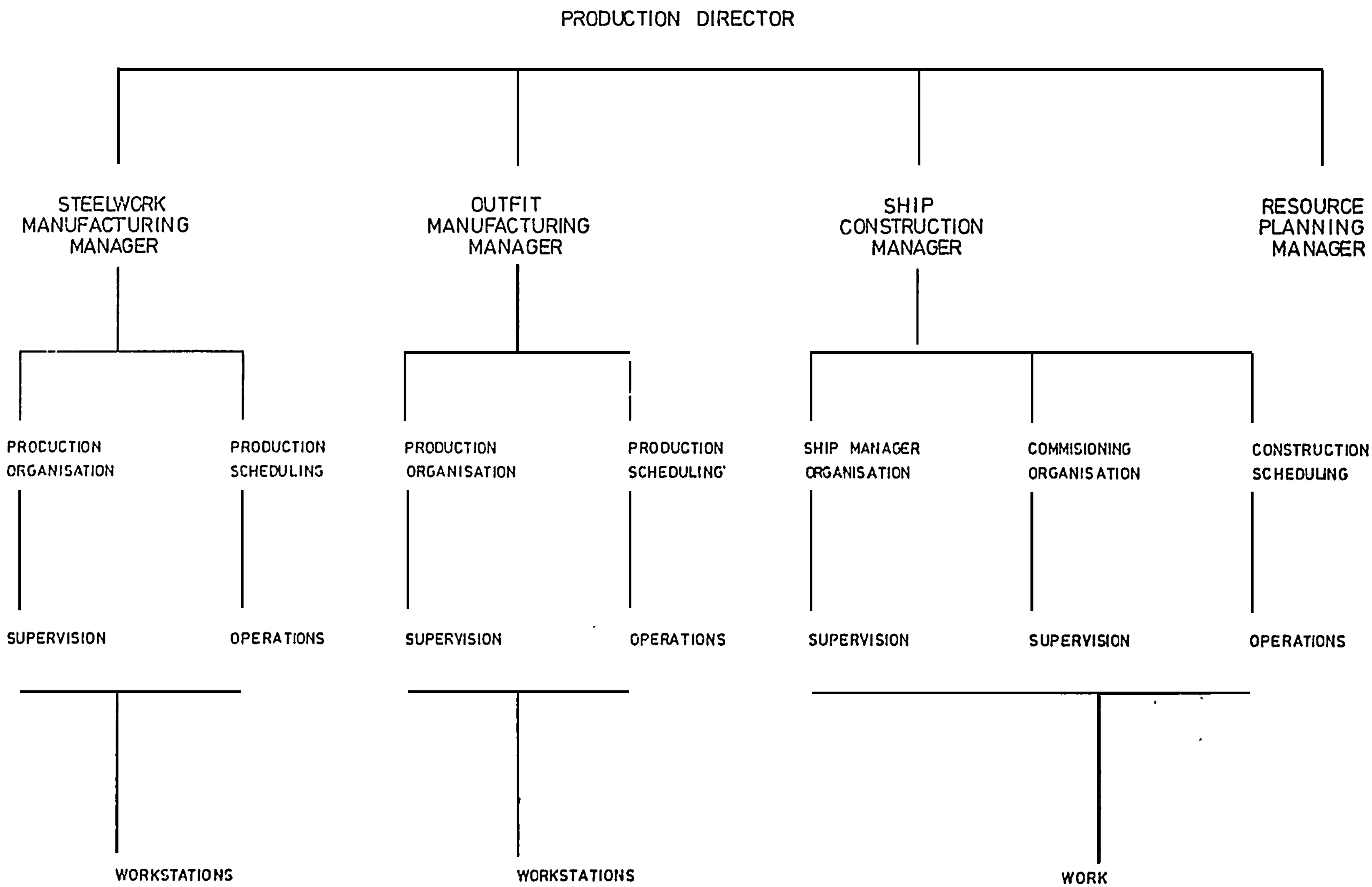
PRODUCTION DIRECTOR
STEELWORK MANUFACTURING MANAGER
OUTFIT MANUFACTURING MANAGER
SHIP CONSTRUCTION MANAGER
RESOURCE PLANNING MANAGER
PROCUCTION ORGANISATION
PRODUCTION SCHEDULING
PRODUCTION ORGANISATION
PRODUCTION SCHEDULING
SHIP MANAGER ORGANISATION
COMMISIONING ORGANISATION
CONSTRUCTION SCHEDULING
SUPERVISION
OPERATIONS
SUPERVISION
OPERATIONS
SUPERVISION
SUPERVISION
OPERATIONS
WORKSTATIONS
WORKSTATIONS
WORK

FIGURE 1

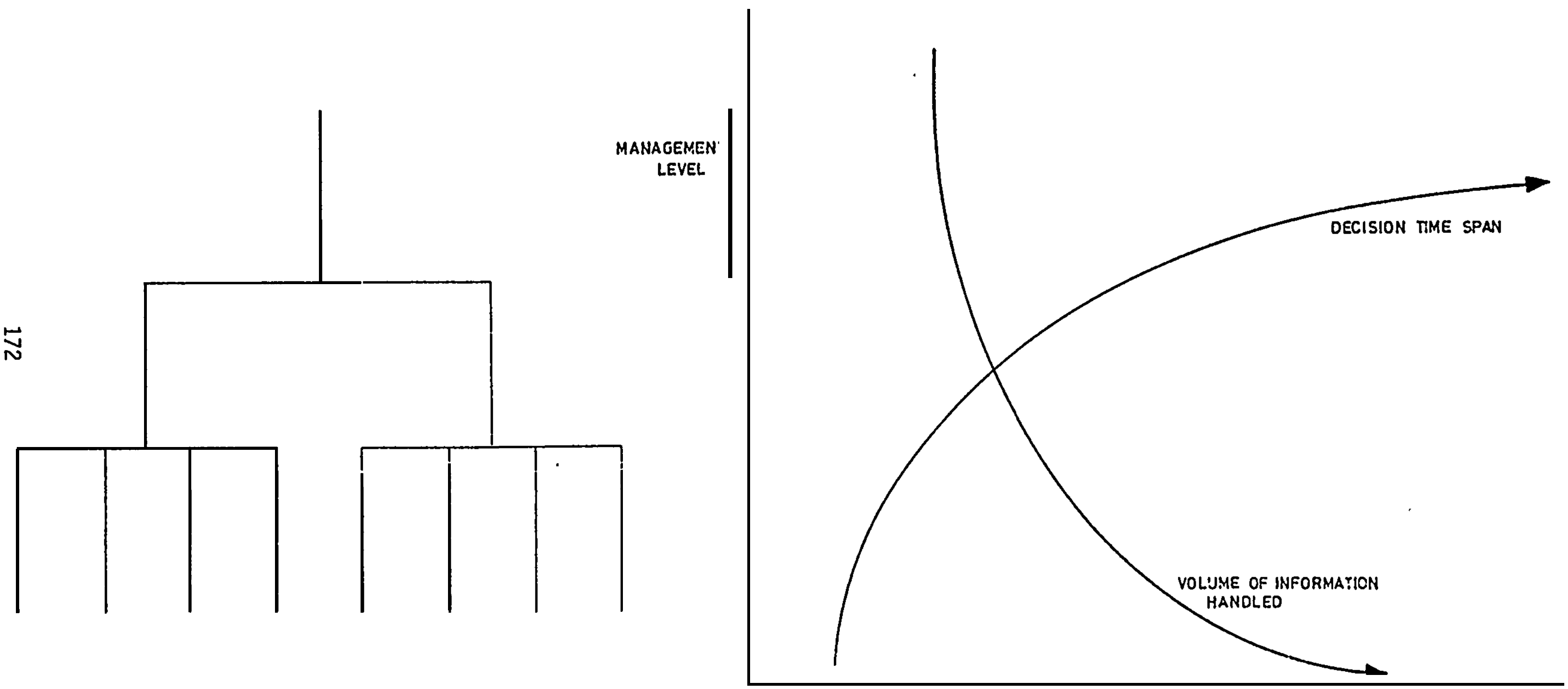
MANAGEMENT
LEVEL
DECISION TIME SPAN
VOLUME OF INFORMATION
HANDLED

FIGURE 2

responsible to the same assistant manager. Assistant managers and production schedulers are likewise juxtaposed and so are production department managers and the resource planning manager.

This organizational concept does not encourage the use of a central main frame computer, and the problem of data transmission and effective co-ordination remains. Looking at production control in this way, in terms of the total information flow within the organization, the case for or against computers can be determined purely in terms of the amount of information to be processed rather than the availability of a particular technique.

In many smaller shipyards, manual procedures are quite adequate. In larger shipyards, especially where the variety of ships produced is high, computer processing is probably essential. In order to preserve the proximity of control procedures to the management they are designed to support, distributed computing, using a mini-computer network, should be considered. In any event, the interface with computer facilities should be designed so that each manager can consider the system from his point of view to be ‘his system’.

SCHEDULING TECHNIQUES

The enhancement of production control has been, in the past, and even now is sometimes looked at in terms of the importation of a particular scheduling technique. PERT and CPM are good examples.

Networking suddenly became the cure-all for production control problems. More recently, scheduling packages, often designed for the general engineering industry, were applied. The problem is not so simple.

Scheduling packages of this kind simulate the real world. In the case of networks, the simulation concentrates on the logical relationship between the start and finish of sequential activities. Networking was a major breakthrough. Unfortunately, its success depends on there being a relatively small number of alternative sequences of work. This is particularly acceptable in the case of on-board outfitting where the physical relationship between outfit items often determines that there is only a limited number of alternative sequences. Management can then choose the preferred sequence and draw the network logic.

Where there are large amounts of float or slack, other means have to be found for deciding exactly when an activity shall take place. Often, a solution can be mathematically defined from a resource allocation process. The result may not, however, be optimal and careful study may be required by management of the results of any such process.

Network analysis is totally inappropriate to detailed workshop scheduling where the individual sequences may be determined by a combination of process sequence, batch production and

production line balancing. In some cases, simulation using packages designed for engineering have been used. Success has not been high because the choice between the large num - ber of possible activity sequences is often made by internally generated priorities.

The algorithms used to generate priority may be satisfactory where there is a large number of assemblies prod- uced. This is not the case in shipbuilding. The net result is that the progress made against a schedule issued at the start of a week may determine a different set of internal priorities at the end of a week. The schedule produced for the start of the next week (for which some operations may already be under- way) may differ dramatically from the one expected. Such changes are totally confusing to the shop floor. In short, these scheduling methods are unstable in the shipbuilding context. A new approach is required.

THE CONCEPTS IN SPCS

This rather long explanation of the uses and abuses of production control in the shipbuilding industry helps to explain why SPCS was developed and why it is not just another new package. It is the first attempt to look at the information and control require- ments for the management of production operations from top to bottom.

The assembly flow process of shipbuilding is itself used in the design of an information system, with each module of that system using techniques and procedures relevant to a specific production area. Rather than replacing management decision making, SPCS supports it by supplying the right information at the right place at the right time. The amount of information to be processed will depend on the size and complexity of the ship, the rate of output and the lead time allowed before production.

The use of the information is three-fold. Firstly, the various databases can be interrogated to supply data on the state of all operations. Secondly, the information can be used to assess the feasibility of different strategies, thus limiting schedules to a small number of those which are possible but leaving foremen free to choose the one which is most appropriate. Thirdly, the systems can be interrogated to provide answers to "What if ?" questions. This is particularly important at the corporate planning level where the ever changing scenarios of future orders require the treasury and manpower functions to be able to forecast requirements.

Where a scheduling algorithm is required, it is designed to be uncomplicated and to reproduce the way in which local management would determine priority. In most areas, however, rather than scheduling by simulation (which requires complex algorithms) the time available for a set of tasks is allocated on the basis of a physical scheduling parameter which

can be used to assess performance as well as progress at each work station. This scheduling method allows specific control over inter-process buffer storage levels and major sequences reflecting the overall relationships between assemblies. Minor sequences relating to short term machine loadings are left to the discretion of foremen.

For example, while satisfying the assembly schedule for the ship as a whole, it is possible for foremen to vary the precise sequence of production in the shop to a limited extent, in order that an even work load is maintained in the work shops.

SHIP PRODUCTION CONTROL

The objective of any production control system must be:

- to provide all levels of management and supervision with timely and accurate information that will enable them to contribute effectively to the performance of the shipyard as a whole.

Shipbuilding is a complex process that requires design, drawing, material procurement, manufacturing and construction activities to be co-ordinated. So what, therefore, are management's information needs ? The questions that must be answered by the system will depend upon the level of management under consideration. For example, foremen will need to know:

- What is the next job ?
- What material is required for that job ?
- Is the material available ?
- If material is available, where is it located ?
- Is the technical information available ?
- If material or technical information is not available, what course of action should be taken ?

Managers must be able to answer questions such as:

What work is required from their area over the next time period ?

- What are the budgets for the work ?

- What resources are required ?

- What is the status of work currently in progress ?

- How is each work station performing ?

Senior executive management will need information on:

- departmental performance

- contract status

- contract performance

- resource utilization.

Without information tailored to his specific needs, no decision-taker, whether foreman, manager or senior executive, can function effectively; if not provided, problems will not be solved at the most appropriate level of management, and ultimately the progress of work on the shop floor will suffer. Also, since the shop floor is the main demand center for, and generator of,

information, it is clear that management's information needs must be linked to the shop floor production control system if effective production and corporate strategies are to be defined.

The resulting flow of information is shown in Figure 3.

Production control systems must be designed to co- ordinate all activities carried out in the shipyard, by breaking down departmental barriers and focusing attention on efficient production. Managers and foremen should then be free to concentrate on the real problems of:

- man management
- cost reduction
- performance improvement
- quality control.

SPCS is a flexible and uncomplicated approach to production control, aiming to supplement management rather than to replace management decision making by black-box decision rules. It consists of a set of inter-tied modules, each of which is executed either manually or by batch computer processing or on-line, depending on local circumstances. The inter-relationship is shown in Figure 4. The modules and their tasks are:

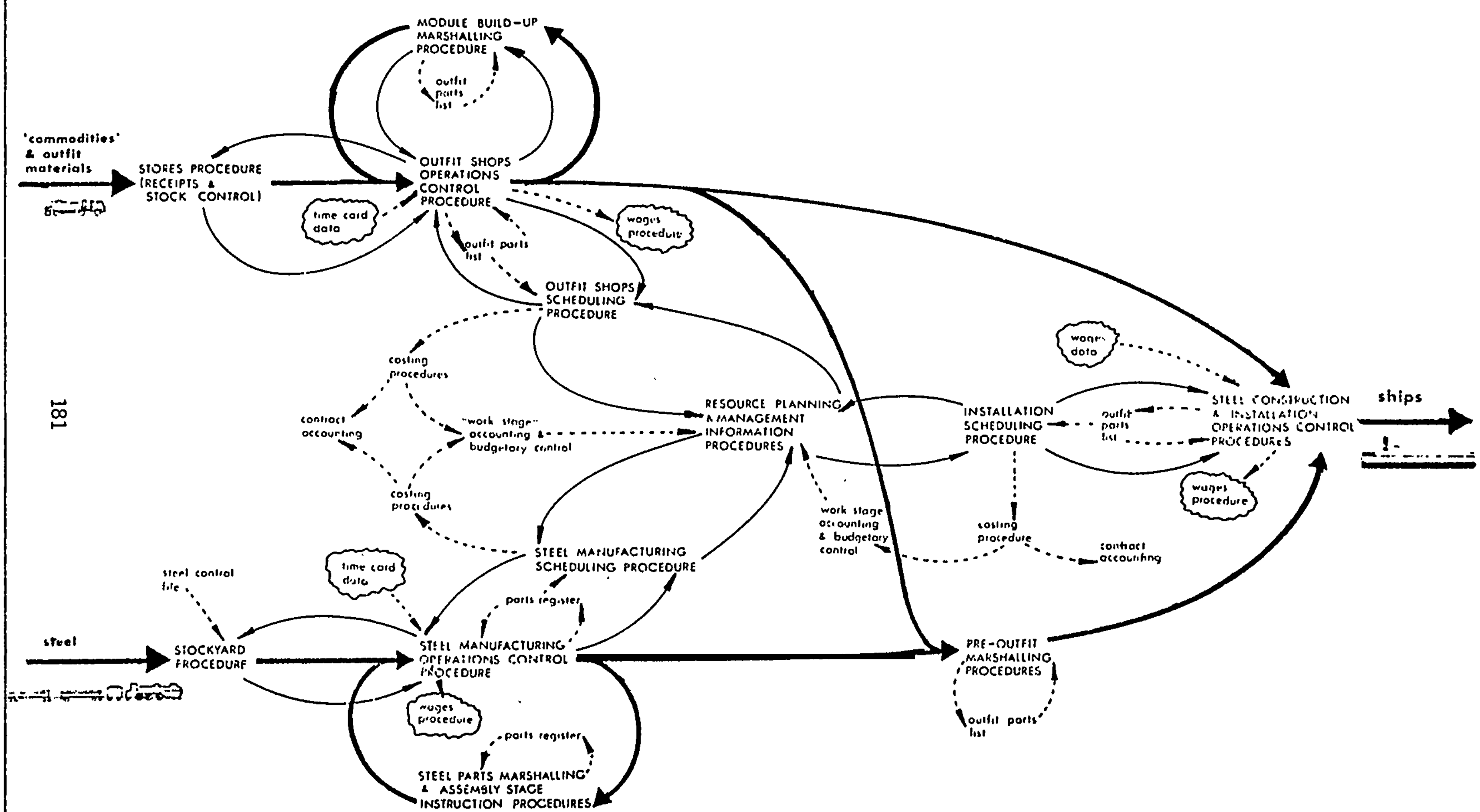

Fig. 3 OVERALL INFORMATION FLOW

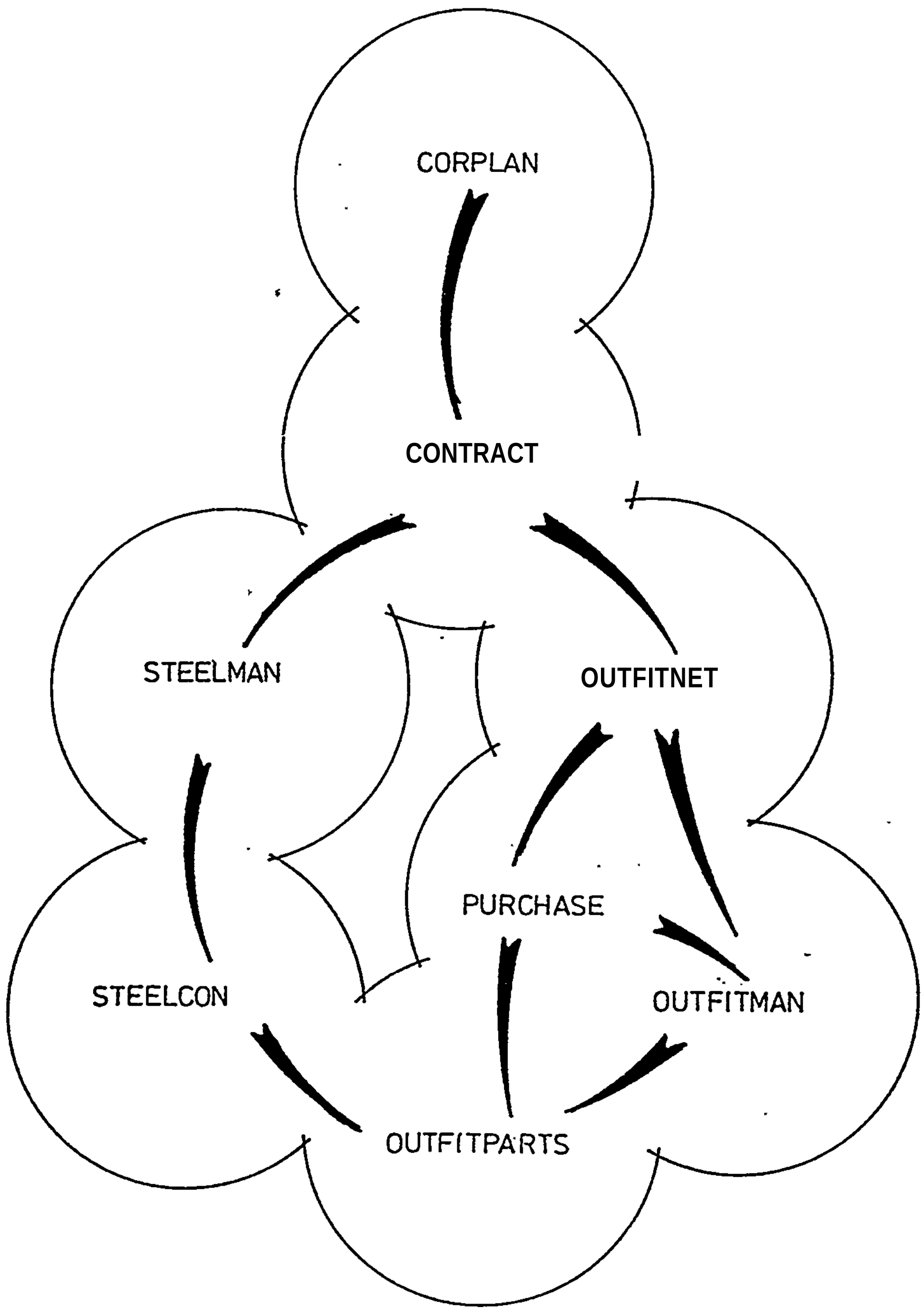
CORPLAN
CONTRACT
STEELMAN
OUTFITNET
PURCHASE
STEELCON
OUTFITMAN
OUTFITPARTS

FIGURE 4

Module	Task
CORPLAN	Corporate planning and scheduling
CONTRACT	Contract scheduling
STEELMAN	Steelwork production scheduling and control
STEELCON	Block assembly and steelwork erection scheduling and control
OUTFITNET	Outfit installation scheduling
OUTFITPARTS	Outfit installation parts control
OUTFITMAN	Outfit manufacturing scheduling and control
PURCHASE	Purchase and stores control

An essential attribute of the system is its flexibility - the version installed in a particular shipyard is specific to that shipyard.

CORPLAN provides a facility for examining the implications of adopting various corporate strategies; the major variables considered are production sequence, labor, availability, labor rates and material prices. The output from CORPLAN is a feasible schedule of dates for keel laying, launch and completion, together with the associated labor curves and cash flow.

CONTRACT is a set of methods and procedures for determining the cardinal date program for each ship production contract. At the heart of the ship production process lies the determination of the erection schedule for the ship, a pivot around which all other scheduling takes place. This module, therefore, is a medium term scheduling tool, allowing the current orderbook to be integrated with the preferred corporate plan. It sets the planning boundaries and constraints within which more detailed scheduling is carried out in subsequent modules.

STEELMAN is designed to solve the problems of steelwork production, scheduling and control. It covers the creation of a plate and stiffener parts database, the control of steel purchasing and delivery and the scheduling and control of steelwork production. Effective use can be made of computer based information handling systems, extending to real time control where appropriate. The detailed design of this module will reflect the organization of work at shop floor level, and the definition of work stations.

STEELCON is a set of procedures for the scheduling and control of block assembly and ship erection activities. It converts the erection scheduling segment of CONTRACT into detailed work station schedules and it interacts with STEELMAN by providing a unit demand schedule. It also provides information to OUTFITNET with regard to completion of onboard zones.

OUTFITNET is approach to the problem of scheduling outfit installation work. The concept of work station organization is applied to onboard installation, providing a facility for predicting both bought-in and manufactured material requirement dates - essential to the efficient control of outfit material to the ship, and to the organization of the purchasing and manufacturing functions.

OUTFITPARTS provides information on the availability and location of installation parts. Technical and production data is merged with the ship production schedule, to provide material requirements. This allows management action to be concentrated on delinquent items.

OUTFITMAN is a combined parts listing and shop scheduling system for manufactured parts. It provides a technical database for piece parts and produces shop schedules for manufacture and assembly to match the demand for installation parts.

PURCHASE provides a means of ensuring that material is available in the shipyard to support the building program. It enables bought-in materials to be effectively progressed and provides timely information on the availability of outfit material to production departments.

Production control systems are only a part of the overall shipyard operating system. SPCS modules have been designed to handle and process technical information. Clearly, the format of technical information must be. decided on the basis of the needs of production. However, the fact that production control must process the information should also be considered.

An important output from SPCS is management information. Management information reports are prepared from data collected on the shop floor and therefore consideration has been given to the methods of data collection and processing. Solutions to these problems are part of each SPCS module, together with management information report formats.

The accounting function must also receive information from production departments on work completed and manhours used to enable payroll systems to operate, to revise forecasts and prepare operating statements. SPCS modules are designed to ensure an effective interface between production and accounting functions.

SAVINGS AND BENEFITS

Having established the necessity for production control, the question most often asked is - "[What savings will be achieved by implementing a production control system ?" The savings made will depend upon:

a) the situation in a shipyard before implementation

b) the commitment given by shipyard management to making systems work

c) the effort put into training and familiarization.

In order to identify areas in which savings can be made, consider an alternative statement of the objective of a production control system. It is:

- to ensure that there is a continuous and correctly sequenced flow of work through manufacturing and ship construction work stations.

This means that by providing information on material requirements and status, it is possible to control material and information flows so that neither the man on the shop floor, nor his foreman has to search for the "next job". Therefore, idle time on the shop floor will be substantially reduced and quality levels improved because of a more effective use of supervision. And if the dimensional accuracy of fabricated units is improved, savings can be made at the building berth stage.

A further point to be considered is the job satisfaction of shop floor personnel. Frustration builds up when men find themselves idle because of material or technical information shortages, and this frustration can be a contributory cause of absenteeism and high labor turnover.

A good production control system will therefore enable resources, labor and equipment to be used efficiently. But if it is to be effective it must be implemented on a broad front. For example, it is not practicable to introduce a system to schedule steelwork production in isolation; for such a procedure to be effective, it must receive inputs from the technical departments - drawings, material lists and key date information from central or resource planning. In addition, the procedure will need fee dback on work completed and hours worked, in order to verify scheduling parameters and prepare useful management reports.

It was with all these considerations in mind that A & P Appledore designed their ship production control system, now known as SPCS.

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